PATENT ABSTRACTS OF JAPAN

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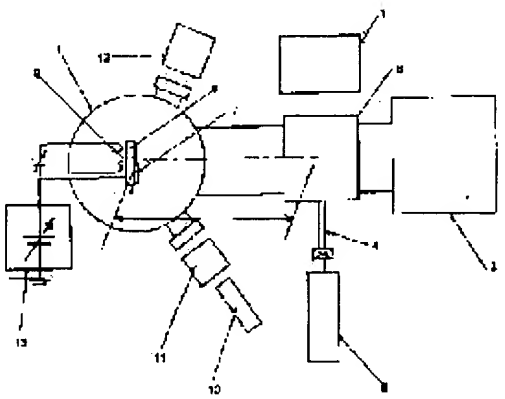
(54) MANUFACTURE OF EXTRA-THIN SILICON OXIDATION FILM EXPRESSING MOS CHARACTERISTICS

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an extra-thin silicon oxidation film that is created at ambient temperature and expresses MOS characteristics, by plasma-oxidizing a surface of a silicon substrate under constant ambient temperature with positive or negative voltage applied to the silicon substrate or without applying voltage.



SOLUTION: A vacuum chamber 1 is exhausted by a pump 2 and it keeps at vacuum pressure. O2 gas accumulated in O2 gas bomb 5 is introduced to a plasma-generating region 6 through O2 gas supply line 4 and plasma-oxidized by driving a plasma generator 3 controlled by a power controller. A silicon substrate 7, where an oxidation film is created on its surface, installed on a susceptor 8 that is capable of applying positive or negative voltage to a vacuum chamber 1 grounded and negative bias voltage is applied by a power source 13 for a substrate voltage. When increasing temperature of the susceptor 8 more than ambient temperature for material baking, it is heated by flowing an electric current through a resistance wire 9.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] Invention of this application relates to the ultra-thin silicon oxide obtained by the manufacture method of the ultra-thin silicon oxide which discovers an MOS property, and this method. It is related with the ultra-thin silicon oxide obtained by the still more detailed manufacture method of the ultra-thin silicon oxide which discovers an MOS property with invention of this application useful as a generation method of the oxidization insulator layer on the front face of silicon, and this method.
[0002]
[Description of the Prior Art] Conventionally, as a generation method of an ultra-thin silicon oxide, although the thermal oxidation film generation method is known, establishment of 10nm or less of thickness and the generation process of ultra-thin silicon 5 morenm or less is made into pressing need with reduction-izing of a semiconductor device in recent years. Then, since it is necessary to control thickness to high degree of accuracy (1A or less of errors), maintaining homogeneity in order to obtain a usable oxide film in an ultra-thin field, it is O2. The attempt which generates an ultra-thin oxide film by the method (following plasma oxidation and abbreviated name) of supplying a silicon oxidization kind according to the plasma process of gas has been made.
[0003] However, it sets to the conventional plasma oxidation method. Since to maintain substrate temperature 500K or more is needed while adding positive bias to a substrate, in order to obtain a usable oxide film, on this condition Since an oxide-film growth rate is too quick, control of thickness was difficult when oxidization thickness is an ultra-thin field, and substrate temperature was too high, the trouble of being unable to prevent diffusion of the impurity which exists in a substrate was during oxide-film growth. Furthermore, the oxide film generated by the conventional method had the problem that thickness was as thick as 20-30nm (D. A.Carl et al., J.Appl.Phys., 70, 3301 (1991)). For this reason, in the former, an oxide film is generated at a room temperature and the oxide film which discovers an MOS (metal-oxide-film-semiconductor) property in the field of 5nm or less of thickness is not obtained.
[0004] Then, invention of this application aims at offering the ultra-thin silicon oxide which discovers an MOS property generable at a room temperature, and its manufacture method.
[0005]
[Means for Solving the Problem] Invention of this application offers the manufacture method (claim 1) of the ultra-thin silicon oxide of 10nm or less of **** which have the MOS property characterized by holding a silicon substrate to a room temperature and carrying out plasma oxidation of the silicon-substrate front face, without impressing positive or negative bias voltage to a silicon substrate, or impressing as what solves the above-mentioned technical problem.
[0006] Furthermore, invention of this application offers the above-mentioned manufacture method (claim 2) characterized by oxidization thickness being 5nm or less. Moreover, thickness also offers an ultra-thin silicon oxide (claim 4) 5nm or less further with the ultra-thin silicon oxide (claim 3) of 10nm or less of thickness to which invention of this application discovers an MOS property in a silicon-

substrate front face.
[0007]
[Embodiments of the Invention] In invention of this application, diffusion of an impurity is prevented by controlling an oxidization growth rate, raising the thickness-control nature in an ultra-thin field, and maintaining substrate temperature at a room temperature further by this, by impressing positive or negative bias to a substrate in plasma oxidation.
[0008] An ultra-thin silicon oxide (10nm or less and 5 morenm or less) will be offered for the thickness which discovers an MOS property by this. From well-known old technology or old well-known knowledge, it cannot hit on an idea of the generation by the plasma oxidation of the ultra-thin silicon oxide in such room temperature level at all, and the predominance of this invention is mentioned especially.
[0009] About generation of the above ultra-thin silicon oxide, it exhausts and decompresses, and has a means by which positive and negative bias can be impressed at a silicon substrate in the vacuum chamber which can be made into the so-called vacua (for example, pressure of 1x10 - 5 or less Pa), and the equipment of various kinds of modes which can carry out plasma oxidation of the silicon substrate, and a system are adopted.
[0010] A thing proper as what was supplied as a means for plasma oxidation through transportation of the plasma particle from the plasma made to generate by excitation of microwave, a RF, etc. for example or efficient consumer response plasma, and the plasma made to generate by plasma production meanses various [these] further is employable. Oxygen content gas will be used for the plasma oxidation in this case. Although oxygen gas is shown as the typical thing, unless the plasma oxidation of this invention is checked, it is rare gas and N2. You may make the inert gas to say live together.
[0011] Generally let about -60-+60V be a standard preferably about the bias voltage impressed to a silicon substrate at -100 - a +100V grade, and a pan. Furthermore, the range of the grade of -60-+10V, for example, the voltage of negative bias, is illustrated as a suitable thing.
[0012] Although it has been thought by the former that impression of bias voltage is not desirable as what spoils membranous homogeneity, it is not necessary to impress bias voltage or, and it may carry out a seal of approval by the method of making substrate temperature in this invention a room temperature. Especially impression of negative bias voltage or the positive bias voltage to about 60V produces an effect more notably. moreover -- although it is different about plasma oxidation with the method and scale of equipment and a system -- general -- the excitation power for the plasma production of oxygen gas (O2) -- up to [about 800W] -- the plasma density in a silicon-substrate surface region -- 6x1011-/cm3 up to a grade -- 1x105 to 6x1011-/cm3 etc. -- let the range be a standard
[0013] In addition, about a silicon substrate, it bakes beforehand and may be made to perform surface cleaning-ized processing. Hereafter, an example is shown and this invention is explained in more detail.
[0014]
[Example] Drawing 1 of the appended drawing shows an example of a system which carries out this invention. For example, as shown in this drawing 1 , a vacuum chamber (1) is exhausted with a pump (2), and is maintained at a vacuum. O2 O2 stored in the chemical cylinder (5) Gas is introduced into a plasma generating field (6) from the supply line (4), and is plasma-ized by the operation of the plasma generator (3) controlled by the power controller.
[0015] The silicon substrate (7) by which an oxide film is generated by the front face is arranged in the susceptor (8) which can impress positive and an electronegative potential to the vacuum chamber (1) which is a ground, and negative bias voltage is impressed by the power supply for substrate voltage impression (13). When raising the temperature of a susceptor (8) beyond a room temperature for sample baking, it can heat by passing current to resistance wire (9).
[0016] moreover, the oxide film generated on the substrate front face -- the object for ellipsometers -- the thickness is measured by the ellipsometer which consists of light-receiving equipment for the incident-light study system (11) ellipsometers for light source (10) ellipsometers (12) Drawing 2 of the appended drawing shows the relation between the oxidization thickness generated by this invention, and oxidization time.

[0017] In drawing 1 , distance (L) from the central point of a plasma generating field (6) to the front face of the silicon substrate (7) of a vacuum chamber (1) is set to about 100mm. A supply line (4) to O2 Gas was supplied and the range of the bias voltage the excitation power in a plasma generator (3) minds 200-600W (the plasma density 107 - 108/cm3), and a susceptor (8) was set to -60-+60V.
[0018] As shown under this condition at drawing 2 , the thickness control of oxidization thickness became possible in the field 5nm or less. Moreover, the homogeneity of the thickness of the generated oxide film was 0.1nm or less. Moreover, drawing 3 of the appended drawing shows the MOS property (capacitance-voltage characteristic) of the oxide film (2.8nm of thickness which generated impression bias voltage-60V and substrate temperature in the room temperature) generated by the method of this invention.
[0019] As shown in drawing 3 , the oxide film generated by this invention showed the good MOS property.
[0020]
[Effect of the Invention] As explained in detail above, generation of the ultra-thin oxide film which discovers an MOS property in a room temperature in the plasma oxidation process of the plasma substrate of a silicon substrate by invention of this application is enabled.

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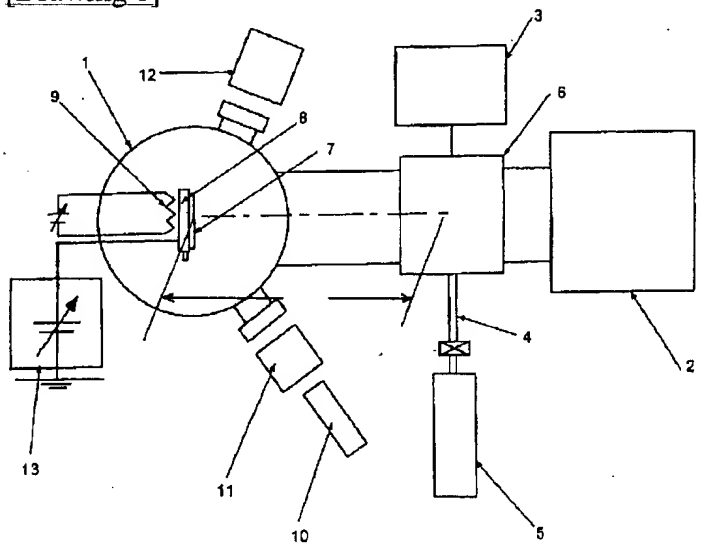
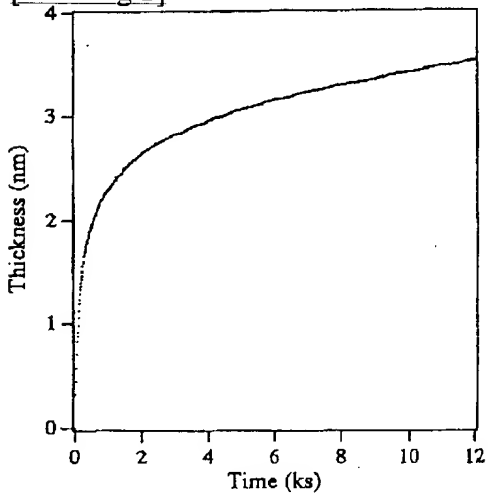
DRAWINGS

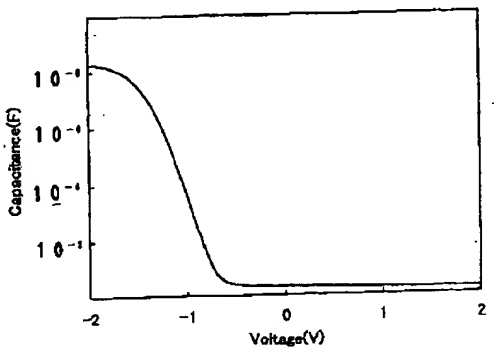
[Drawing 1]



[Drawing 2]



[Drawing 3]



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